CLAIMS

1. A method of controlling a motor running at an operating speed, the method comprising:

determining a speed error between the operating speed and a commanded speed;

adjusting a turn-on angle in response to the speed error; and

switching to a voltage control when the turn-on angle reaches a retardation limit.

2. The method of claim 1, wherein switching to the voltage control comprises:

activating a regulator when the turn-on angle reaches a retardation limit; and

scaling down a duty cycle output at the regulator; and

reducing the control voltage.

3. The method of claim 1, further comprising establishing a commanded voltage limit, wherein the commanded voltage limit is a preset percentage of the operating speed.

4. The method of claim 3, wherein the preset percentage is about 90%.

5. The method of claim 1, further comprising detecting the operating speed.

6. The method of claim 1, wherein adjusting the turn-on angle comprises:

generating an angle command by proportionally integrating the speed error; and

clipping the angle command when the angle command is outside an angle limit.

7. The method of claim 1, wherein switching to the voltage control further comprises:

generating a voltage command;

generating a regulated speed by multiplying the speed error by a voltage regulating percentage; and

scaling the voltage command using the regulated speed.

8. The method of claim 1, wherein adjusting the turn-on angle further comprises maintaining a voltage-frequency relationship.

9. The method of claim 6, wherein the voltage-frequency relationship comprises a constant voltage per hertz equation.

10. A method of controlling a motor running at an operating speed, the method comprising:

determining a speed error between the operating speed and a speed command;

adjusting an angle command to minimize the speed error while maintaining a voltage-frequency relationship;

determining a retardation limit of the angle command from the speed; and

switching to a voltage control when the retardation limit is reached.

11. The method of claim 10, wherein adjusting the angle command further comprises running the motor at a constant voltage-frequency relationship.

12. The method of claim 11, wherein the voltage-frequency relationship comprises a voltage per hertz equation.

13. The method of claim 10, further comprising determining a voltage command from the speed command and the operating speed.

14. The method of claim 12, further comprising:

compensating the voltage command with a voltage compensation limit; and

adjusting a duty cycle with the compensated voltage command.

15. The method of claim 10, further comprising adjusting an output duty cycle using the speed error.

16. The method of claim 10, wherein the voltage-frequency relationship further comprises a constant voltage-frequency relationship.

17. The method of claim 15, wherein the constant voltage-frequency relationship comprises a voltage per hertz equation.

18. The method of claim 10, further comprising switching between the voltage control and adjusting the turn-on angle with at least three voltage regulators.

19. The method of claim 10, wherein switching to the voltage control further comprises:

generating a voltage command to the motor;

generating a regulated speed by multiplying the speed error by a voltage regulating percentage; and

scaling the voltage command using the regulated speed.

20. A control system of a motor, the control system comprising:

a comparator configured to compare a feedback speed and a commanded speed, and to generate a speed difference between the feedback speed and the commanded speed;

an angle control coupled to the comparator, and configured to receive the speed difference, and to adjust a turn-on angle in response to the speed difference; and

a voltage control configured to be activated when the turn-on angle reaches a retardation limit, and to generate a voltage command.

21. The motor control system of claim 20, wherein the voltage control further comprises a voltage command limiter configured to limit the voltage command, and to generate a limited voltage command.

22. The motor control system of claim 20, wherein the voltage control further comprises at least one voltage regulator configured to regulate the voltage command, to reduce the voltage command when the commanded speed drops below a threshold, to generate a voltage regulating percentage, to adjust an duty cycle of the voltage command, and to maintain a constant voltage-frequency relationship.

23. The motor control system of claim 20, wherein the angle regulator further comprises a proportional integrator configured to minimize a turn-on angle error.

24. The motor control system of claim 20, further comprising a cascade accumulator configured to smooth a voltage increase transition.